NSRL Extraction Bump Study Plan Outline

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Objective: This study has two basic aims:

1. The primary goal is to verify the results of the transfer matrix calculations used to control the positions at the D3 and D6 extraction septa in the Booster as well as the angle at the D6 septa.

2. The study will also be used as an opprtunity to calibrate the BPM system.

Tools: Operational BPMs
BoosterOrbitDisplay application
BoosterOrbitControl application
FunctionEditor

Pre-Study Activities: In order to complete the activities of the study and analyze the data produced in the study, it will be necessary to complete the following pre-study activities:

- Verify that all of the features of the BoosterOrbitDisplay application are functional including the ability to acquire data from all operational BPMS, save data, recall data, calculate difference orbit data, and be able to operate online in such a manner as to be able to verify results as they are acquired. Efforts should be made to correct any deficiencies in operation before the study.

- Verify that the BoosterOrbitControl application is also working properly and that orbit distortion can be applied and changed as needed.

It would also be useful to conduct several activities to check and verify machine performance:

- The equilibrium orbit of the Booster should be checked at various field values. This work can be done on the ramp to verify that the orbit does not shift significantly during the ramp or at various beam energies. At flattop the situation becomes more complicated because extraction equipment begins turning on, however, the equilibrium orbit should not change significantly. Significant change could have adverse effects on bump performance and extraction efficiency.

Study Activities

For all of the following activities the Booster should remain in the following configuration:

1. It is expected that the Booster shall be configured for running with Fe^{+20}.

2. The RF system will remain on during the closed-orbit distortion to keep the beam bunched until extraction.

3. The resonant sextupoles should be turned off.

4. The tune of the Booster should be kept at or close to 4.33.

5. The extraction radius should be held constant.

6. The option will be held open to conduct the test at both 1 GeV ($B\rho$ = 15.85749372) and 600 MeV ($B\rho$ = 11:55950682) energies

Stage One: <u>BPM Verification and Calibration</u>

1. A set current value will be applied to each of the extraction backleg windings for NSRL (C7, D1, D4, D7, E1) individually.

2. Orbit data will be collected at each of the BPMs and compared to the expected values of the orbit for each powered backleg winding.

Stage Two: <u>Closed Orbit Bumps</u>

1. Proper currents will be applied to all of the extraction backleg windings based on the expected values of the positions at D3 and D6 and the expected angle at D6. A variety of orbit bumps will be created according to the following scenarios:

   - Positions at D3 and D6 are the same, angle varied at D6
   - Positions at D3 and D6 are unequal, angle varied at D6

   For each scenario, several positions at the D3 and D6 septa will be established, and, for each set position of the D3 and D6, the angle will be varied at D6.

2. BPM orbit data will be collected at each operational BPM and compared to the expected values of the orbit trajectory.

The following positions, angles, and currents are expected to be used for Fe^{+20} at 1 GeV ($B\rho$ = 15.85749372).

Target D3 Position (m)	Target D6 Position (m)	Target Angle at D6 (rad)	Trial Currents				
			C7	D1	D4	D7	E1
0.0040	0.0040	0.0010	414.2	-401.9	375.8	-240.9	99.6
0.010	0.010	0.0020	435.0	-581.3	359.1	-410.3	90.3
0.020	0.020	0.0030	-331.2	-315.4	-442.6	-436.7	-137.0
0.022	0.022	0.0032	-484.4	262.3	-603.0	-442.0	-182.4
0.022	0.022	0.0034	-244.2	-431.7	-370.8	-518.8	-118.9
0.024	0.024	0.0036	-397.4	-378.5	-531.2	-524.1	-164.4
0	0.02	0.0016	-71.1	50.1	412.4	-100.6	581.4
0	0.02	0.0018	-311.3	219.5	180.2	-23.8	517.9
0	0.02	0.0020	-551.5	389.0	-51.9	52.9	454.4
0.015	0.020	0.0026	-290.7	-206.8	-493.1	-283.2	-264.0
0.015	0.020	0.0028	-50.4	-376.2	-261.0	-360.0	-200.4
0.015	0.020	0.0030	189.8	-545.6	-28.8	-436.7	-137.0
0.015	0.025	0.0032	-32.7	-388.7	-364.0	-334.8	-345.8
0.015	0.025	0.0034	207.6	-558.1	-131.9	-411.6	-282.3
0.015	0.030	0.0036	-14.9	-401.2	-467.2	-309.7	-491.2
0.015	0.030	0.0038	225.4	-570.7	-235.0	-386.4	-427.7
0.020	0.030	0.0038	-295.6	-340.5	-648.8	-386.4	-427.7
0.020	0.030	0.0040	-55.3	-509.9	-416.7	-463.2	-364.2

3. The option to change to a lower energy may also be exercised during this activity.

Stage Three: Difference Orbits from an Established Bump Trajectory

1. Once a bump is established, a small change to the positions and or angles will be performed using the table of values above and a new difference orbit obtained using the BoosterOrbitDisplay application.

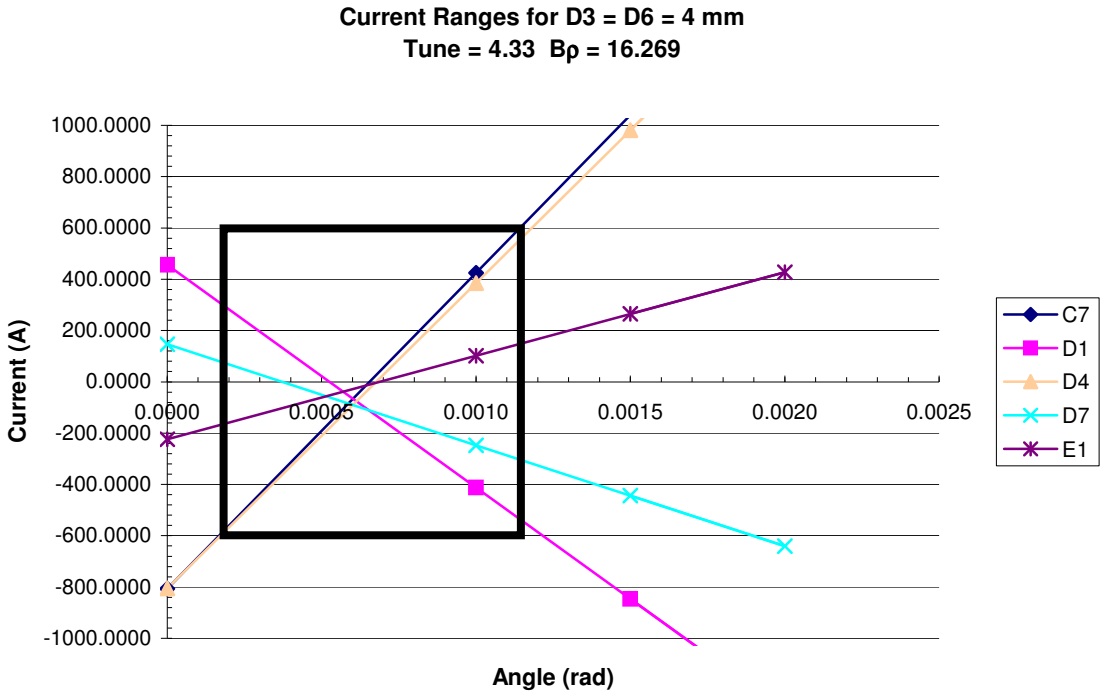
2. This will be repeated for several established bump trajectories to obtain difference orbits.

Appendix

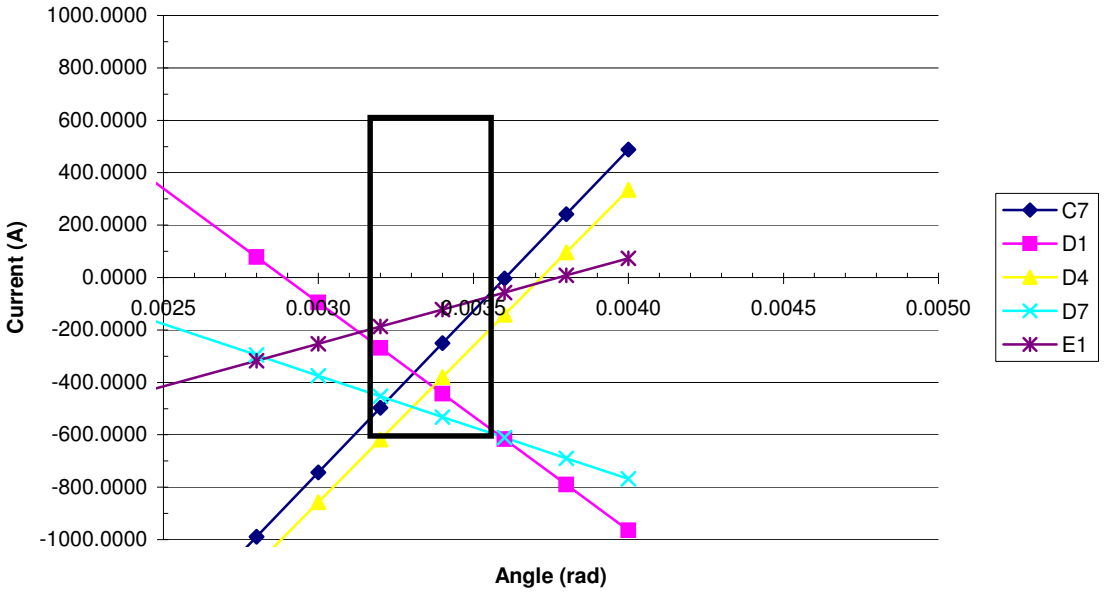
Current Simulation Data for Positions at D3 and D6 and Angles at D6 for Iron at extraction energy and Tune = 4.33

The following graphs show the currents for various positions at the D3 and D6 septa and angles at the D6 septum. Each graph states the target transverse position at the septa for the simulation and shows a box which marks the specific range of available currents and angles based on the limits of the backleg winding power supplies (+/- 600 A).

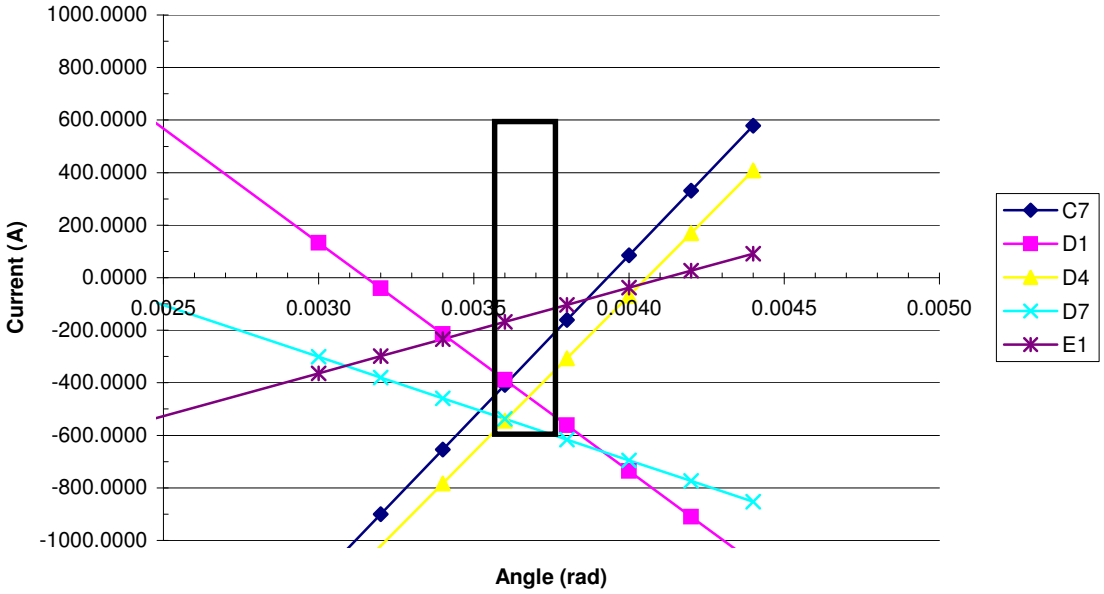
Of immediate interest is the narrow range of angles available before the power supplies ramp outside of their ranges. Because of this narrowness, each choice for transverse position in D3 and D6 almost corresponds to a single available angle.



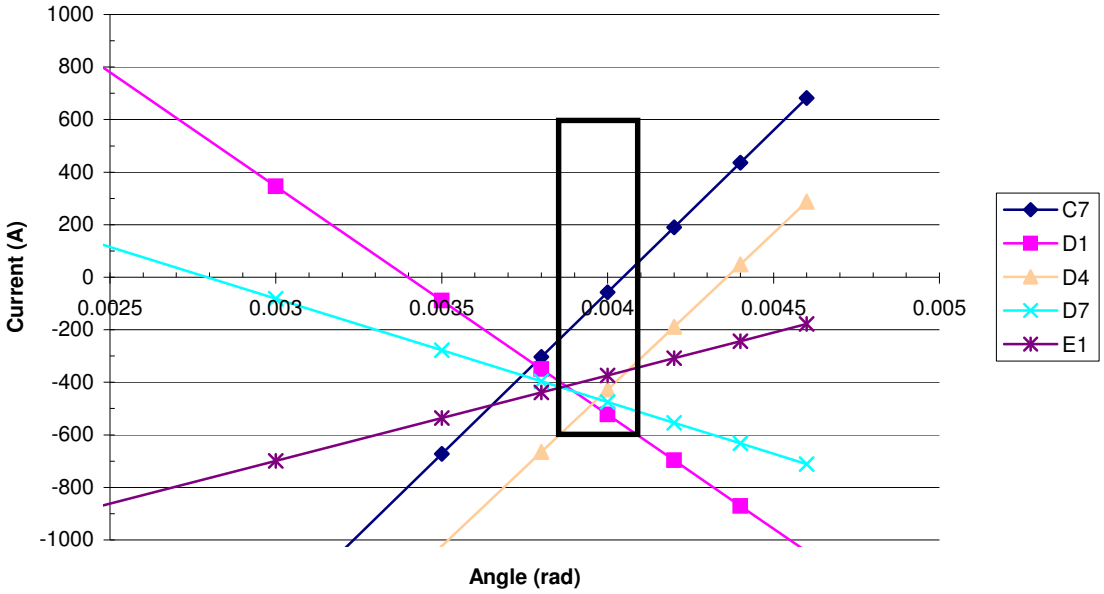
Currents for D3 = D6 = 2.2 cm
Tune = 4.33 Bρ = 16.269



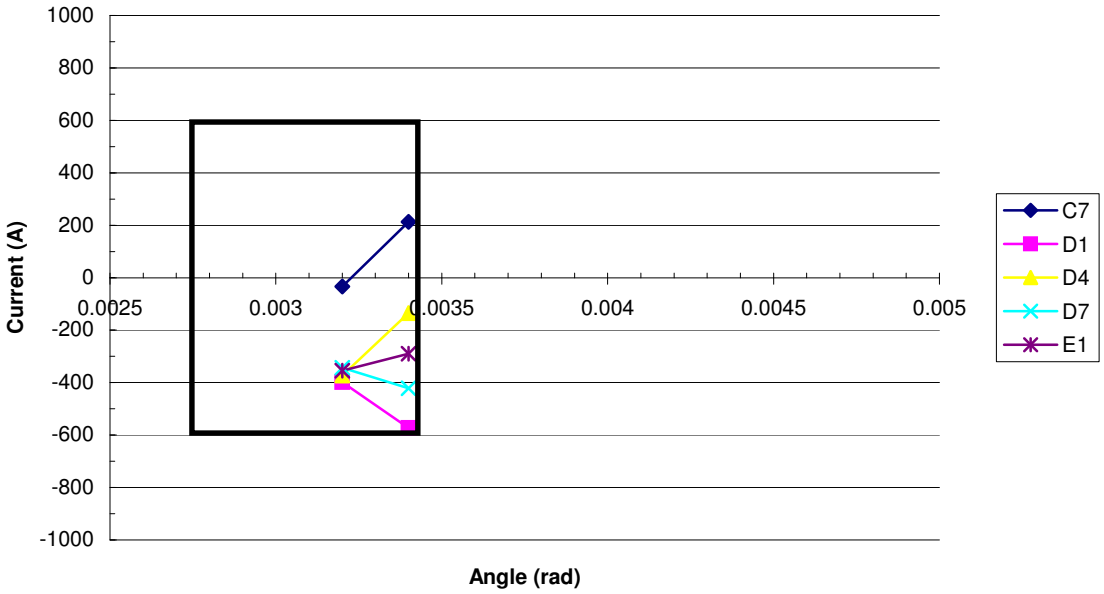
Currents for D3 = D6 = 2.4 cm
Tune = 4.33 Br = 16.269



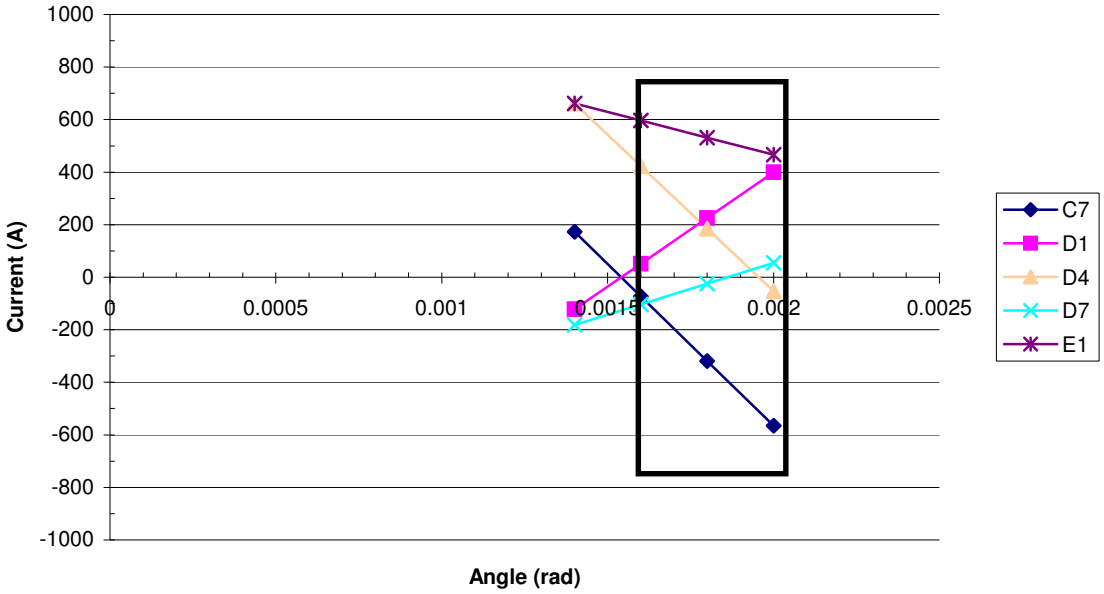
Currents for D3 = 2 cm & D6 = 3 cm
Tune = 4.33 Br = 16.269



Currents for D3 = 1.5 cm & D6 = 2.5 cm
Tune = 4.33 Bρ = 16.269



Currents for D3 = 0 cm & D6 = 2 cm
Tune = 4.33 Br = 16.269



Currents for D3 = 1.5 cm & D6 = 3 cm
Tune = 4.33 Bρ = 16.269